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## **Report Title**

Climate Change and Cities in Africa: Current Dilemmas and Future Challenges

### **ABSTRACT**

How will climate change affect people living in African cities? The answer to this complex question has two interrelated dimensions. It hinges on, first, the scope of future climate change and resulting changes in population exposures to weather-related hazards and, second, the degree of vulnerability of urban populations to these hazards. The concept of vulnerability used here recognizes that how an urban population experiences weather hazards depends upon the living conditions and development patterns, past and present, in cities. By assessing the intersections of climate change, hazards, and vulnerability, one can better understand the projected effects of climate change on urban populations in Africa. Following this understanding of the challenge, analysts can explore the major policy implications for African governments of building adaptation strategies to address these potential hazards. To explore this question in detail, this course module has three sections: (1) Climate Change: What Is It and Why Is It a Threat? (2) Climate Change in Africa: Exposure and Hazards, (3) Impacts in Urban Africa: Urbanization and Vulnerabilities.

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THE ROBERT S. STRAUSS CENTER™  
FOR INTERNATIONAL SECURITY AND LAW



# Climate Change and Cities in Africa: Current Dilemmas and Future Challenges

Robert H. Wilson, PhD

October 2014

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The Robert S. Strauss Center for International Security and Law at The University of Texas at Austin is a nonpartisan research center that engages the best minds in academia, government, and the private sector to develop unique, policy-relevant solutions to complex global challenges.

## About the CCAPS Program

The Climate Change and African Political Stability (CCAPS) program conducts research in three core areas, seeking to investigate where and how climate change poses threats to stability in Africa, identify strategies to support accountable and effective governance in Africa, and evaluate the effectiveness of international aid to help African societies adapt to climate change. The CCAPS program is a collaborative research program among the University of Texas at Austin, the College of William and Mary, Trinity College Dublin, the University of Denver, and the University of North Texas.

The CCAPS program is funded by the U.S. Department of Defense's Minerva Initiative, a university-based, social science research program focused on areas of strategic importance to national security policy. Through quantitative analysis, GIS mapping, case studies, and field interviews, the program seeks to produce research that provides practical guidance for policy makers and enriches the body of scholarly literature in this field. The CCAPS team seeks to engage Africa policy communities in the United States, Africa, and elsewhere as a critical part of its research.

## About the Author

Robert H. Wilson is the Mike Hogg Professor of Urban Policy at the Lyndon B. Johnson School of Public Affairs at the University of Texas at Austin.

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# Learning Objective

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## *How will climate change affect people living in African cities?*

The answer to this complex question has two interrelated dimensions. It hinges on, first, the scope of future climate change and resulting changes in population exposures to weather-related hazards and, second, the degree of vulnerability of urban populations to these hazards. The concept of vulnerability used here recognizes that how an urban population experiences weather hazards depends upon the living conditions and development patterns, past and present, in cities. By assessing the intersections of climate change, hazards, and vulnerability, one can better understand the projected effects of climate change on urban populations in Africa. Following this understanding of the challenge, analysts can explore the major policy implications for African governments of building adaptation strategies to address these potential hazards.

To explore this question in detail, this course module has three sections:

- (1) Climate Change: What Is It and Why Is It a Threat?
- (2) Climate Change in Africa: Exposure and Hazards,
- (3) Impacts in Urban Africa: Urbanization and Vulnerabilities.

Each section defines a set of terms and issues, poses discussion questions, and introduces additional resources about the topic. In order to provide context, the case of flooding in Lagos, Nigeria in 2012 is used as a scenario in each section. Each section can stand alone, but the sections are structured to build on each other to provide a self-paced learning approach easily adapted to individual learners or group settings.

## Scenario: Flooding in Lagos, Nigeria

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*The purpose of this scenario is to provide a real-world example that illustrates the concepts developed in each section of the module and provides a basis for discussion or an activity through which learners and teachers can test knowledge gained. Questions about this scenario are provided at the end of each of the module's three sections. However, these questions could be consolidated into a capstone activity to be conducted after completing the three sections.*

Nigeria, located in West Africa, is the most populated country in Africa with a population projected to grow from 158 million in 2010 to 193 million in 2020.<sup>1</sup> A former British colony, the country has developed one of the largest economies in Africa, benefiting from abundant oil reserves.<sup>2</sup> Its governmental structure is a federal republic, and its legal system has elements of common law, Islamic law, and customary law.<sup>3</sup>

The city of Lagos, located in a state with the same name, is the primary economic center of the country and is a booming metropolis with a population projected to reach 14 million by 2020.<sup>4</sup> The city is located on a coastal lagoon and built on a series of islands. Between May and September, Nigeria experiences an annual rainy season and, frequently, flash floods. These flash floods can be deadly, especially in the rural areas and overcrowded urban areas like Lagos, where drainage systems are inadequate. In 2012, the worst flooding in half a century began in early July and by November had killed 363 people and displaced approximately 2 million Nigerians.<sup>5</sup> The president of Nigeria declared the flooding a national disaster.<sup>6</sup>

**Exercise:** Take twenty minutes to research the 2012 floods in Nigeria giving special attention to the situation of Lagos. During the initial research period, articulate your understanding of the concepts of climate change, climate hazards, and urban vulnerability within the Nigeria scenario. Record in written notes your thoughts before continuing to the next section.

<sup>1</sup> UN-HABITAT and UNEP, *The State of African Cities: Governance, Inequality, and Urban Land Markets* (Nairobi: UN-HABITAT, 2010), 240.

<sup>2</sup> The World Bank, "Nigeria: Overview," World Bank, [www.worldbank.org/en/country/nigeria/overview](http://www.worldbank.org/en/country/nigeria/overview).

<sup>3</sup> CIA World Factbook, "Nigeria," CIA World Factbook, [www.cia.gov/library/publications/the-world-factbook/geos/ni.html](http://www.cia.gov/library/publications/the-world-factbook/geos/ni.html).

<sup>4</sup> UN-HABITAT and UNEP, *The State of African Cities: Governance, Inequality, and Urban Land Markets*, 246.

<sup>5</sup> "Nigeria Floods Displace Two Million, Kill 363," *BBC News*, November 6, 2012.

<sup>6</sup> F. Onuah, "Nigeria President Calls Floods a 'National Disaster'," *The Star Online*, October 12, 2012.

For more background on Nigeria, Lagos, and the 2012 Nigerian floods, see:

Federal Republic of Nigeria, [www.nigeria.gov.ng](http://www.nigeria.gov.ng)

Lagos State Government, [www.lagosstate.gov.ng](http://www.lagosstate.gov.ng)

BBC News Africa, "Nigeria Profile," [www.bbc.co.uk/news/world-africa-13949550](http://www.bbc.co.uk/news/world-africa-13949550)

The Guardian, "Floodwaters Recede in Nigeria but Millions Remain Displaced and Hungry," 13 November 2012, [www.theguardian.com/global-development/2012/nov/13/floodwaters-nigeria-millions-displaced-hungry](http://www.theguardian.com/global-development/2012/nov/13/floodwaters-nigeria-millions-displaced-hungry)

IRIN, "Nigeria: Worst Flooding in Decades," 10 October 2012, [www.irinnews.org/report/96504/nigeria-worst-flooding-in-decades](http://www.irinnews.org/report/96504/nigeria-worst-flooding-in-decades)

Voice of America, "Humanitarian Crisis Looms after Deadly Nigerian Floods," 30 October 2012, [www.voanews.com/content/humanitarian\\_crisis\\_looms\\_after\\_deadly\\_nigerian\\_floods/1536206.html](http://www.voanews.com/content/humanitarian_crisis_looms_after_deadly_nigerian_floods/1536206.html)

## Climate Change: What Is It and Why Is It a Threat?

The primary scientific forum for the study of climate change is the Intergovernmental Panel on Climate Change (IPCC), created in 1988. It defines climate change as, "a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity."<sup>7</sup> A principal cause of climate change is the release of greenhouse gases, like carbon dioxide, methane, and nitrous oxide, into the atmosphere, partially trapping longwave radiation (which manifests as heat) that naturally emanates from Earth's atmosphere.<sup>8</sup>

One piece of scientific evidence of climate change has been an increase in the average global temperature along Earth's surface since the 1850s, with a very distinct rise during the last three decades.<sup>9</sup> However, this pattern of average atmospheric warming is just one element of climate change. Atmospheric temperature interacts with other natural systems, such as the oceanic system, in complex ways with the result that the average temperature rise is not observed in all parts of the globe.<sup>10</sup> Furthermore, and importantly for this module, climate change has diverse effects on weather patterns, including an increase of variability in precipitation and storm patterns in many parts of the world.

What is causing the increase in greenhouse gas emissions? In recent decades, advancements in climate science have allowed for increasingly powerful evidence that current patterns of climate change have been influenced by human activity.<sup>11</sup> In particular, greenhouse emissions increased substantially with the advent of the Industrial Revolution at the end of the 19th century<sup>12</sup> and have continued thereafter at increasing levels.<sup>13</sup> Emissions continue to grow today, primarily due to "burning fossil fuels to produce energy, although deforestation, industrial processes, and some agricultural practices also emit gases into the atmosphere."<sup>14</sup> These processes increase the production of greenhouse gases and decrease the Earth's natural ability to regulate temperature.<sup>15</sup>

Due to the changing weather patterns that climate change generates, human societies face major threats. Weather-related hazards, such as flooding, heat stress, water scarcity, sea level rise, and storm surges, are expected to become more common, although their frequency will vary across regions of the globe, and even within a single region. Human societies are typically framed around stable climate environments, but water supplies, agriculture production, infrastructure, the natural environment, and human health and security will be adversely affected by anticipated changes in weather patterns.<sup>16</sup>

<sup>7</sup> L. Bernstein et al., *Climate Change 2007: A Synthesis Report* (Cambridge: Cambridge University Press, 2007), 30.

<sup>8</sup> See EPA, "Causes of Climate Change," [www.epa.gov/climatechange/science/causes.html](http://www.epa.gov/climatechange/science/causes.html).

<sup>9</sup> Intergovernmental Panel on Climate Change (IPCC), "Summary for Policy Makers," in *Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. T.F. Stocker et al. (Cambridge: Cambridge University Press, 2013), 5.

<sup>10</sup> IPCC, "Summary for Policy Makers," *Climate Change 2013*, 5-8.

<sup>11</sup> United Nations Framework Convention on Climate Change (UNFCCC), "United Nations Framework Convention on Climate Change," 1992, 9. See also IPCC, "Summary for Policy Makers," 11-12.

<sup>12</sup> IPCC, *Climate Change 2007, The Physical Science Basis*, eds. Solomon et al. (Cambridge: Cambridge University Press, 2007), 13-14.

<sup>13</sup> Environmental Protection Agency (EPA), "Climate Change: Basic Information," [www.epa.gov/climatechange/basics](http://www.epa.gov/climatechange/basics).

<sup>14</sup> Ibid.

<sup>15</sup> UNFCCC, "United Nations Framework Convention on Climate Change."

<sup>16</sup> EPA, "Climate Change: Basic Information."



International communities and national governments are increasingly addressing the causes and consequences of climate change. Attempts to reduce greenhouse emissions in order to reduce the rate of increase in global warming are called climate change mitigation strategies (see Key Definitions box). In addition, governments have become increasingly concerned about the potential disasters related to climate events, such as the flooding in Nigeria, the scenario used in this module. Nations typically mobilize resources for disaster response, but governments and non-governmental actors are seeking strategies to reduce the risk associated with disasters in climate change adaptation strategies.

These concepts of climate change hazards will be illustrated for Africa in the following section.

### Discussion Questions

- (1) Does the description of climate change presented here match your previous understanding of this phenomenon?
- (2) Is there anything new you learned about this concept?
- (3) How and where can you see climate change in your work and/or personal life?
- (4) Is climate change affecting the annual natural hazard of flooding in Lagos, Nigeria every year? If so, how?

## Key Definitions

*UNISDR defines key concepts as follows:*<sup>17</sup>

**Adaptation:** “The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities...Adaptation can occur in autonomous fashion, for example through market changes, or as a result of intentional adaptation policies and plans. Many disaster risk reduction measures can directly contribute to better adaptation.”

**Capacity:** “The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals...Capacity may include infrastructure and physical means, institutions, societal coping abilities, as well as human knowledge, skills and collective attributes such as social relationships, leadership and management. Capacity also may be described as capability. Capacity assessment is a term for the process by which the capacity of a group is reviewed against desired goals, and the capacity gaps are identified for further action.”

**Disaster:** “A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.”

**Disaster risk management:** “The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.”

**Disaster risk reduction:** “The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.” A document describing the goals, objective and activities is a disaster risk reduction plan.

**Hazard:** “A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.”

**Mitigation:** In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other “sinks” to remove greater amounts of carbon dioxide from the atmosphere.

**Vulnerability:** “The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard....There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element’s exposure.”<sup>18</sup>

<sup>17</sup> UNISDR terminology on disaster risk reduction is available at [www.unisdr.org/we/inform/terminology](http://www.unisdr.org/we/inform/terminology).

<sup>18</sup> Adapted from IPCC, “Section 18.1.2: Differences, Similarities and Complementarities between Adaptation and Mitigations,” in *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change*, eds. M.L. Parry et al. (Cambridge: Cambridge University Press, 2007).

# Climate Change in Africa: Exposure and Hazards

No region of the world is unaffected by climate change exposure, a term applied in climate change discussions to capture the risk of loss to people, property, and systems in a region as a result of a climate event.<sup>19</sup> But being exposed to a climate hazard does not fully capture potential loss. The Fourth Assessment Report of the IPCC identifies Africa as “one of the most vulnerable continents to climate change and climate variability”<sup>20</sup> due partly to climate exposure, but also to low adaptive capacity and high vulnerability to climate-related hazards such as flooding, drought, and sea level rise.<sup>21</sup> Before addressing the concept of vulnerability in the next section, these three primary hazards present in urban areas in Africa will be explored.

## Flooding

Increasing temperatures and elevated atmospheric temperature are projected to shift the frequency, intensity, duration, and timing of storms worldwide. Although much of Africa will actually have less precipitation, the intensity of storms is projected to increase. This means that extreme heavy rainfall that previously occurred once every 20 years will now occur once every 15 years.<sup>22</sup> In terms of regional differences in exposure, projections show increased precipitation in areas of western Africa and eastern Africa. This rain will likely be concentrated during current heavy-rain periods. Coastal areas are especially subject to flooding as a result of both precipitation events and sea level rise. An estimated 54 million Africans live in vulnerable Low Elevation Coastal Zones (LECZ)—defined as areas 10 meters or less above sea level—and this figure is projected to rise to over 100 million by 2030.<sup>23</sup> Areas around rivers and creeks are also susceptible to riverine flooding, though localized flooding occurs outside these areas as well, especially in more heavily developed settings. Flooding can cause significant human and economic losses and is unique in the visibility of its effects, as both a fast-onset and localized hazard.

## Water Scarcity

Despite projections for increased exposure to flooding in many parts of Africa, many regions are also at risk of water scarcity and drought. Annual variation in precipitation and heavy but short precipitation events mean that the same areas that are subject to flooding can also be subject to drought. Different climate models predict a 20 percent decrease in overall rainfall along the Mediterranean coast of North Africa, northern Sahara, and west coast of Africa by 2099. Additionally, southern Africa is estimated to see a 30 percent decrease in rainfall during the already dry winter period.<sup>24</sup> These projections suggest increased frequency of droughts as well as heightened water scarcity.<sup>25</sup> Drought is already a major issue in Africa, with one-third of the population living in drought-prone areas.<sup>26</sup> As soon as 2020, increases in water stress due to climate change may affect between 90 and 220 million people across the continent.<sup>27</sup>

## Sea Level Rise

Sea level rise is due primarily to melting of land-based ice and thermal expansion, or the expansion of water as it warms.<sup>28</sup> In addition to inundation of low-lying areas, sea level rise can lead to coastal erosion and damage of infrastructure and built areas along the coast. Many major cities of Africa are coastal, including Lagos. Given these population concentrations and current projections for sea level rise, the homes of an estimated 16 to 27 million people across the continent could be flooded annually by 2100, amounting to 5 to 9 billion dollars per year in damage.<sup>29</sup> North Africa is considered particularly vulnerable to sea level rise, especially along the Nile Delta in Egypt where land elevation is especially low.<sup>30</sup> Sea level rise can also contribute to water scarcity since saltwater intrusion can contaminate underground aquifers that serve as an important source of drinking water, especially for poorer populations not connected to water networks. Similar to water scarcity, sea level rise tends to have a slower onset time, though its effects are localized and visible.

<sup>19</sup> UNISDR, “Terminology.”

<sup>20</sup> See executive summary of M. Boko et al., “Africa,” in *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change*, eds. M.L. Parry et al. (Cambridge: Cambridge University Press, 2007).

<sup>21</sup> M. Boko et al., “Africa.”

<sup>22</sup> IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, eds. C.B. Field et al. (Cambridge: Cambridge University Press, 2012), 7, 25, 143.

<sup>23</sup> Foresight: Migration and Global Environmental Change, Future Challenges and Opportunities, Final Project Report (London: The UK Government Office for Science, 2011), Fig. 3.1, 84, [www.bis.gov.uk/assets/foresight/docs/migration/11-1116-migration-and-global-environmental-change.pdf](http://www.bis.gov.uk/assets/foresight/docs/migration/11-1116-migration-and-global-environmental-change.pdf).

<sup>24</sup> M. Boko et al., “2007: Africa,” section 9.3.1 referencing D. A. Hudson and R. G. Jones, “Regional Climate Model Simulations of Present-Day and Future Climates of Southern Africa,” Technical Note 39 (Bracknell: Hadley Centre for Climate Prediction and Research, 2002).

<sup>25</sup> M. Falkenmark, J. Lundquist, and C. Widstrand, “Macro-scale Water Scarcity Requires Micro-scale Approaches: Aspects of Vulnerability in Semi-arid Development,” *Natural Resources Forum* 13, 4 (1989), 258-67.

<sup>26</sup> I. Niang, L. Otter, and D. Olago, “Vulnerability, Impacts, and Adaptation to Climate Change,” in *Global Change Processes and Impacts in Africa: A Synthesis* (Nairobi: East African Publishers, 2007).

<sup>27</sup> UNFCCC, “Africa,” [http://unfccc.int/essential\\_background/the\\_science/climate\\_change\\_impacts\\_map/items/6224.php](http://unfccc.int/essential_background/the_science/climate_change_impacts_map/items/6224.php).

<sup>28</sup> UN-HABITAT, *Global Report on Human Settlements 2011: Cities and Climate Change* (Nairobi: UN-HABITAT, 2011), 66.

<sup>29</sup> J. Hinkel et al., “Sea-level Rise Impacts on Africa and the Effects of Mitigation and Adaptation: An Application of DIVA,” *Regional Environmental Change* 12, 1 (2012), 221.

<sup>30</sup> UN-HABITAT, *Global Report on Human Settlements 2011*, 66.

<sup>31</sup> J. Busby et al., “Locating Climate Insecurity: Where Are the Most Vulnerable Places in Africa?” in *Climate Change, Human Security and Violent Conflict*, Hexagon Series on Human and Environmental Security and Peace, Vol. 8 (London: Springer, 2012), 5, 16.

It is important to call attention to the uncertainty surrounding these projections. Climate modeling tools are most effective at modeling the magnitude and distribution of global temperature change, but modeling of weather patterns and especially precipitation is more difficult. The error associated with climate models is compounded by a lack of research and climate data in several African countries.<sup>31</sup> Despite uncertainty on climate projections, policy makers currently face and will continue to face challenges associated with increased variability and intensity of precipitation events throughout the continent.

### **Discussion Questions**

- (1) Why are cities vital in addressing and adapting to climate change?
- (2) Who are the important actors in addressing climate change aside from cities?
- (3) What issues arise from uncertain climate modeling projections? What could the implication of this uncertainty be for government officials? Policy makers? The average citizen?
- (4) How is flooding impacting the city and people of Lagos, Nigeria, in the short term? In the long term?
- (5) Considering Lagos, Nigeria, how is climate change threatening the city outside the example of flooding previously mentioned? Are these forces influencing one another?

## **Impacts in Urban Africa: Urbanization and Vulnerabilities**

The distribution of climate change exposure across the globe does not respect national boundaries, but the risks associated with exposure are compounded by significant sources of vulnerability within African countries. The level of vulnerability results from characteristics of human systems, including the built environment, which contribute to establishing the level of harm and damage that can accrue during a climate event.<sup>32</sup> Social, economic, political, and environmental factors can also affect the level of vulnerability.<sup>33</sup> High rates of urbanization coupled with poor urban planning, deficiencies in public services and infrastructure, settlement in hazard-prone areas, and high levels of poverty, illiteracy, and poor health conditions contribute to vulnerability in urban Africa.

A country or city cannot significantly affect its climate exposure, but vulnerability can be reduced through “adjustments in natural and human systems” that can limit the effects of weather hazards.<sup>34</sup> The adaptive capacity of a country depends on the ability of the government, interested organizations, and individuals to prepare for and respond to hazards. The low adaptive capacity, in part related to the continent’s colonial past, makes Africa particularly vulnerable to the impacts of climate change.

### **African Cities and the Colonial Past**

Many of today’s large African cities emerged during the European colonial period. In the 1884/85 Berlin Conference, European powers, including Great Britain, France, Portugal, Germany, Belgium, Italy, and Spain, divided most of the continent into countries and each assumed colonial oversight of specific countries.<sup>35</sup> This political-administrative arrangement continued until independence movements in the middle of the 20th century. The colonizing powers established cities, sometimes built over old settlements, as centers for administrative and political control, but they also facilitated trade and the export of raw materials and resources from the continent to Europe. The development of the colonial cities was conducted in the style of the colonial power and often had the effect of separating colonial administrators from native Africans.<sup>36</sup> Many of the infrastructural features of this style, such as drainage systems and roadways, remain prominent in the plans of African cities today. Although most African countries gained independence by the 1960s, the colonial legacies can still be observed in major cities and these legacies contribute to the challenges of local adaptation that could reduce vulnerabilities.

### **African Cities Today and Climate Change**

In 2010, the African continent reached a population of over one billion and by 2025 it is projected to grow by another 400 million.<sup>37</sup> Much of this population growth is occurring in or migrating to urban areas, such that Africa will pass the 50 percent urban mark in 2030 and will witness the tripling of its urban population between 2010 and 2050.<sup>38</sup> Rapid urban growth poses unique challenges for policy makers and urban planners, especially as it has been associated with the expansion of slums and informal settlements. This phenomenon varies by region, but is generally a result of housing shortages, inadequate infrastructure and urban services, ineffective land markets, and inequality.

<sup>32</sup> UNISDR, “Terminology.”

<sup>33</sup> Ibid.

<sup>34</sup> Ibid.

<sup>35</sup> Martin Meredith, *The Fate of Africa: A History of 50 Years of Independence* (New York: PublicAffairs, 2005), 1-10.

<sup>36</sup> UN-HABITAT, *Global Report on Human Settlements 2009: Planning Sustainable Cities* (Nairobi: UN-HABITAT, 2009), 54.

<sup>37</sup> UN-HABITAT and UNEP, *The State of African Cities: Governance, Inequality, and Urban Land Markets* (Nairobi: UN-HABITAT, 2010) Table 1, Statistical Annex. 238-241

<sup>38</sup> Ibid, 1.

The geographic location of cities often results in high levels of vulnerability. For historical and economic reasons, most major cities in Africa are located along the coast or major bodies of water.<sup>39</sup> The cities' locations helped to make them important economic centers, but also to make them vulnerable to sea level rise and flooding. In many African cities, vulnerability to climate hazards may be largely due to poor urban planning and inadequate infrastructure.<sup>40</sup> Construction in natural drainage corridors, for example, can disrupt the flow of rainwater and result in flooding. While climate change has the potential to increase the exposure of cities to climate hazards, many cities already experience significant impacts from climate events, especially in the case of flooding. Furthermore, slums and informal settlements are often located in flood plains, riverbeds, and marshes, exacerbating the vulnerabilities of these populations.

### **Building Resilience to Climate Change**

African countries increasingly address climate change issues, but they face challenges in building the adaptive capacity required to effectively respond to climate hazards. With highly constrained budgets, governments in Africa face the need for significant public investments in a wide range of services. Limited resources and technical capacity, competing priorities, and fragmentation among government agencies constrain adaptive capacity. In terms of national economies, agriculture—especially rain-fed agriculture—and other climate-vulnerable sectors—such as energy and transportation—are critical sectors and priorities for national governments. The populations in African countries tend to have high rates of poverty, large populations in informal settlements, and limited access to basic infrastructure and social services, not only contributing to vulnerabilities to the effects of climate hazards, especially droughts and flooding, but also limiting these populations ability to develop their own adaptive capacity.<sup>41</sup>

African cities tend to have higher levels of infrastructure development and better access to public services compared to rural areas. High population density in cities can create economies of scale for disaster planning and response, but at the same time can increase the potential for damage in both human and economic terms. For historical and economic reasons discussed above, most major cities in Africa are located along the coast or major bodies of water. The cities' locations helped to make them important economic centers, but also make them vulnerable to sea level rise and flooding. Poor urban planning and inadequate infrastructure make these urban populations more vulnerable. For example, construction in natural drainage corridors can disrupt the flow of rainwater and result in flooding. The risk of increased exposures to climate events is likely and many cities, like Lagos, are already feeling the impact.

For these reasons, many international organizations and researchers have turned their attention to issues of climate change in Africa.<sup>42</sup> Adaptation efforts have tended to focus on rural areas, where the majority of Africa's population currently lives, and where livelihoods are heavily dependent on the climate-vulnerable agricultural sector. However, recent rural-to-urban migration and rapid urbanization has drawn increasing attention from governments and policy communities to the need for building adaptive capacity in urban areas. Local governments in cities can play a key role in addressing vulnerabilities through the provision of local infrastructure and public services, promulgation and regulation of land use and building codes, and delivery of local services that are crucial for effective adaptation to climate change.

While national governments, international organizations, non-governmental organizations, and other actors are currently developing strategies and policies to address climate change impacts, local governments are not being effectively empowered and utilized to develop the adaptive capacity that will be need to respond to this challenge in the future.

### **Discussion Questions**

- (1) What vulnerabilities to climate change are found in urban areas? In what ways do they differ from the challenges in rural areas?
- (2) What challenges do cities, in and outside of Africa, face in building adaptive capacity for climate vulnerability?
- (3) Who is responsible for building urban adaptation to climate hazards and natural disasters? Local governments? National governments? The international community? Is there room for collaboration?
- (4) Considering Lagos, Nigeria, what are the vulnerabilities to climate hazards the city faces?
- (5) In Lagos, how has urbanization affected urban resilience to these hazards?

<sup>39</sup> Ibid, 22-24.

<sup>40</sup> Ibid, 29.

<sup>41</sup> M. Boko et al., "Africa."

<sup>42</sup> See for example IPCC, "Summary for Policy Makers," in *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change*, eds. M.L. Parry et al. (Cambridge: Cambridge University Press, 2007).



# Concluding Exercise, Using the Lagos Scenario

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Upon concluding the three sections of this module, return to your notes from the preliminary research. Answer the following questions as a way to conclude this module.

- (1) Have your understandings of these concepts changed? If so, how and why?
- (2) What was the most surprising thing you learned through this scenario?
- (3) How might the citizens of Lagos better prepare for flooding?
- (4) What actions should local government of Lagos take to reduce vulnerabilities to flooding?
- (5) What roles might international organizations and national governments take to improve local adaptation capacity in cities?
- (6) Is climate change being addressed by your local government? If so, in what ways?

## Additional Resources

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### **Climate Change: What Is the Threat?**

IPCC, *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change*, eds. M.L. Parry et al. (Cambridge: Cambridge University Press, 2007), [www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_fourth\\_assessment\\_report\\_wg2\\_report\\_impacts\\_adaptation\\_and\\_vulnerability.htm](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm).

IPCC, *Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment of the Intergovernmental Panel on Climate Change*, eds. T.F. Stocker et al. (Cambridge: Cambridge University Press, 2013), [www.ipcc.ch/report/ar5/wg1](http://www.ipcc.ch/report/ar5/wg1).

IPCC, *Climate Change 2014: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fifth Assessment of the Intergovernmental Panel on Climate Change*, eds. C.B. Field et al. (Cambridge: Cambridge University Press, 2014), [www.ipcc.ch/report/ar5/wg2](http://www.ipcc.ch/report/ar5/wg2).

Environmental Protection Agency, "Climate Change: Basic Information," [www.epa.gov/climatechange/basics](http://www.epa.gov/climatechange/basics).

L. Schipper and M. Pelling, "Disaster Risk, Climate Change and International Development: Scope for, and Challenges to, Integration," *Disasters* 30, 1 (2006), 19–38.

F. Thomalla, T. Downing, E. Spanger-Siegfried, G. Han, and J. Rockström, "Reducing Hazard Vulnerability: Towards a Common Approach Between Disaster Risk Reduction and Climate Adaptation," *Disasters* 30, 1 (2006), 39–48. <http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9523.2006.00305.x/abstract>

UNISDR, *2011 Global Assessment Report on Disaster Risk Reduction: Revealing Risk, Redefining Development* (Geneva: United Nations International Strategy for Disaster Reduction, 2011), [www.preventionweb.net/english/hyogo/gar/2011/en/home/download.html](http://www.preventionweb.net/english/hyogo/gar/2011/en/home/download.html).

### **Climate Change in Africa: Exposure and Hazards**

M. Boko et al., "Africa," in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change, ed. M.L. Parry et al. (Cambridge: Cambridge University Press), 433–467, [www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter9.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter9.pdf).

J. Busby et al., "Of Climate Change and Crystal Balls: The Future Consequences of Climate Change in Africa," *Air and Space Power Journal Africa and Francophonie* (2012), [www.airpower.au.af.mil/apjinternational/apj-af/2012/2012-3/eng/2012\\_3\\_05\\_Busby.pdf](http://www.airpower.au.af.mil/apjinternational/apj-af/2012/2012-3/eng/2012_3_05_Busby.pdf).

M. Pelling, *Adaptation to Climate Change: From Resilience to Transformation* (London: Routledge, 2011). [http://www.pecm.org.bd/attachment/library/CCA-and-DRR/Mark-Pelling-Adaptation-to-Climate-Change-From-Resilience-to-Transformation-Routledge-\(2011\).pdf](http://www.pecm.org.bd/attachment/library/CCA-and-DRR/Mark-Pelling-Adaptation-to-Climate-Change-From-Resilience-to-Transformation-Routledge-(2011).pdf)

N. Prasad et al., *Climate Resilient Cities: A Primer on Reducing Vulnerabilities to Disasters* (Washington: The World Bank, 2009), <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/0,,contentMDK:21845641~pagePK:146736~piPK:226340~theSitePK:226301,00.html>.

UN-HABITAT, *Global Report on Human Settlements 2011: Cities and Climate Change* (Nairobi: UN-HABITAT, 2011), [www.unhabitat.org/content.asp?cid=9599&catid=7&typeid=46](http://www.unhabitat.org/content.asp?cid=9599&catid=7&typeid=46).

### **Impacts in Urban Africa: Urbanization and Vulnerabilities to Climate in Africa**

*Climate Change at the City Scale: Impacts, Mitigation and Adaptation in Cape Town*, eds. A. Cartwright, S. Parnell, G. Oelofse, and S. Ward (London: Earthscan, 2012).

*Climate Change, Disaster Risk, and the Urban Poor: Cities Building Resilience for a Changing World*, ed. J.L. Baker (Washington: World Bank, 2012).

Egis BCEOM International, IAU-ID, and BRGM, *Climate Change Adaptation and Natural Disaster Preparedness in the Coastal Cities of North Africa* (Washington: World Bank, 2011), [http://cmimarseille.org/\\_src/UD2\\_ClimChange\\_FinalReport\\_EN.pdf](http://cmimarseille.org/_src/UD2_ClimChange_FinalReport_EN.pdf).

I. Niang, L. Otter, and D. Olago, "Vulnerability, Impacts, and Adaptation to Climate Change," in *Global Change Processes and Impacts in Africa: A Synthesis* (Nairobi: East African Publishers, 2007).

M. Pelling and B. Wisner, *Disaster Risk Reduction: Cases from Urban Africa* (London: Earthscan, 2009).

UN-HABITAT, *The State of African Cities 2010: Governance, Inequalities and Urban Land Markets* (Nairobi: UN-HABITAT, 2010), 1, [www.unhabitat.org/content.asp?cid=9141&catid=7&typeid=46](http://www.unhabitat.org/content.asp?cid=9141&catid=7&typeid=46).

